

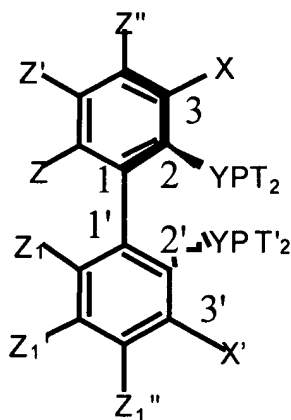
Amendments to the Claims

This listing will replace all prior versions and listings of claims in the application:

Listing of Claims

Claims 1-47. (canceled)

48. (currently amended) A catalyst prepared by a process comprising:
contacting a transition metal salt, or a complex thereof, and a ligand selected
from the group consisting of compounds represented by the formula or its enantiomer:



wherein each X and X' is independently selected from the group consisting of:
alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, halide, SiR₃, P(O)R₂,
P(O)(OR)₂ and P(OR)₂;

wherein each Z and Z₁ is independently selected from the group consisting of:
alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, halide, SiR₃, P(O)R₂,
P(O)(OR)₂ and P(OR)₂; or wherein Z and Z₁ together form the bridging group A-B-A₁;

wherein each Z', Z'', Z₁' and Z₁'' is independently selected from the group
consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR,
halide, SiR₃, P(O)R₂, P(O)(OR)₂ and P(OR)₂; or wherein Z' and Z together form the
bridging group A'-B-A; Z' and Z together form a fused cycloaliphatic or aromatic group;

Z₁ and Z₁' together form the bridging group A₁-B₁-A₁'; and/or Z₁ and Z₁' together form a fused cycloaliphatic or aromatic group;

wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

wherein each B and B₁ is independently selected from the group consisting of: linear, branched or cyclic alkylene of 1 to 6 carbon atoms, arylene of 6 to 12 carbon atoms, O, CH₂, NH, NR, S, CO, SO₂, P(O)R, P(O)OR, POR, SiR₂ and a bond;

wherein each T is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide, aryloxy, R, R', R'', YR', YR'', Y'R' and Y''R''; or wherein two T groups together form an alkylene, arylene, alkylenediamino, arylenediamino, alkylenedioxy or arylenedioxy;

wherein each T' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide, aryloxy, R, R', R'', YR', YR'', Y'R' and Y''R''; or wherein two T' groups together form an alkylene, arylene, alkylenediamino, arylenediamino, alkylenedioxy or arylenedioxy;

wherein each R, R' and R'' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, aralkyl and alkaryl of 1 to 22 carbon atoms; or wherein two R groups, two R' groups or two R'' group together form an alkylene or arelenearylene group; and

wherein each Y, Y' and Y'' is independently selected from the group consisting of: O, CH₂, NH, S and a bond between carbon and phosphorus; with the proviso that when the Y group at the 2' position is a bond between carbon and phosphorus, X' is hydrogen.

49. (currently amended) The catalyst of claim 48, wherein each of said substituted alkyls has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, carboxylic acid, hydroxy, alkoxy, aryloxy, thiol, alkylthio and dialkylamino.

50. (currently amended) The catalyst of claim 48, wherein each of said alkylenes is selected from the group consisting of compounds represented by the formula:

$-(CH_2)_n-$, where n is an integer in the range of from 1 to 8.

51. (previously presented) The catalyst of claim 48, wherein each of said aryl groups optionally has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, sulfonate, phosphonate, hydroxy, alkoxy, aryloxy, thiol, alkylthiol, nitro, amino, vinyl, substituted vinyl, carboxylic acid, sulfonic acid and phosphine.

52. (previously presented) The catalyst of claim 48, wherein each of said arylene groups optionally has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, sulfonate, phosphonate, hydroxy, alkoxy, aryloxy, thiol, alkylthiol, nitro, amino, vinyl, substituted vinyl, carboxylic acid, sulfonic acid and phosphine.

53. (previously presented) The catalyst of claim 48, wherein each of said arylene groups is independently selected from the group consisting of: 1,2-divalent phenyl, 2,2'-divalent-1,1'-biphenyl, 2,2'-divalent-1,1'-binaphthyl and ferrocene.

54. (previously presented) The catalyst of claim 48, wherein said ligand is a racemic mixture of enantiomers.

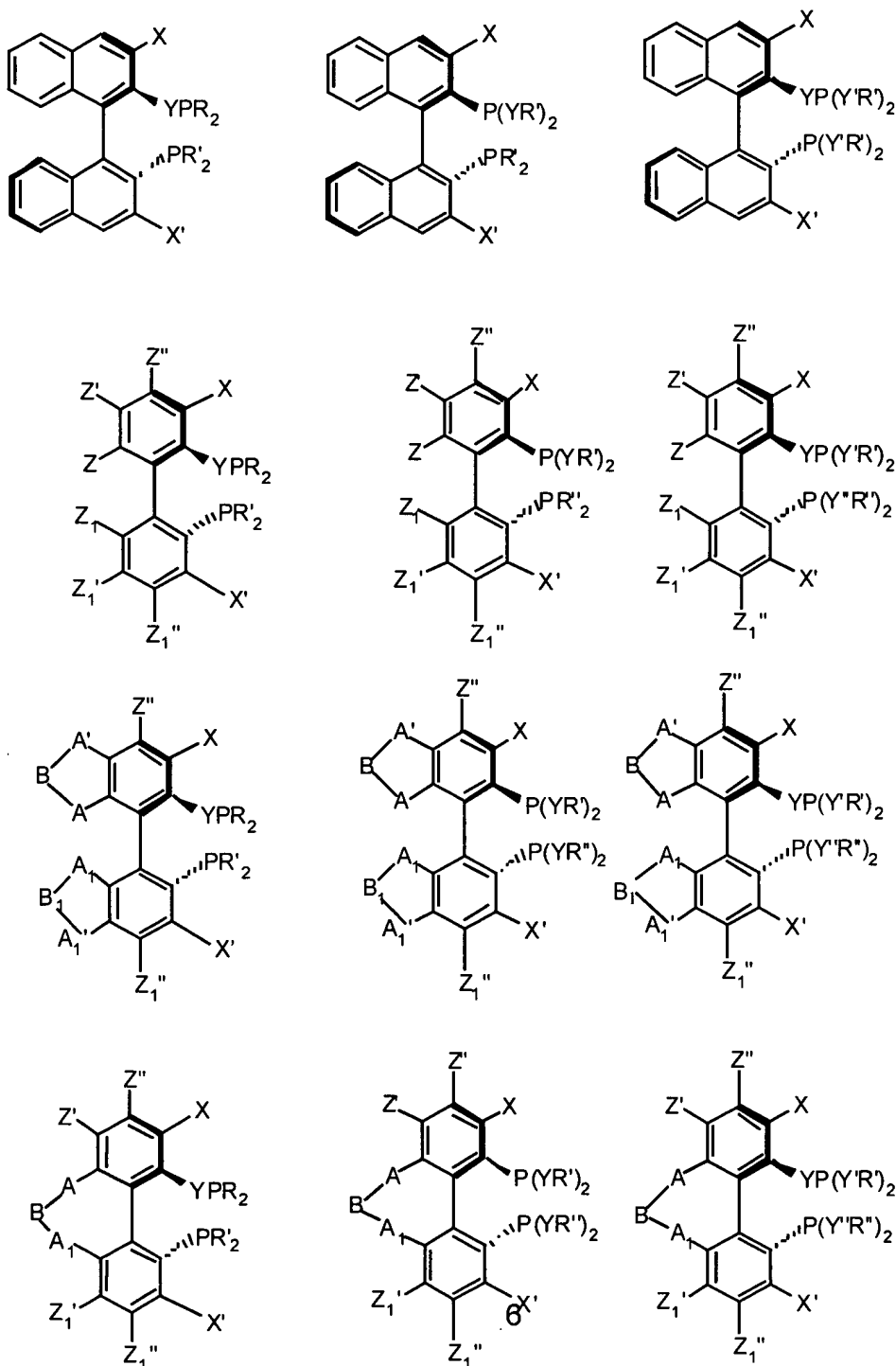
55. (previously presented) The catalyst of claim 48, wherein said ligand is a non-racemic mixture of enantiomers.

56. (previously presented) The catalyst of claim 48, wherein said ligand is one of the enantiomers.

57. (previously presented) The catalyst of claim 48, wherein said ligand has an optical purity of at least 85% ee.

58. (previously presented) The catalyst of claim 48, wherein said ligand has an optical purity of at least 95% ee.

59. (currently amended) The catalyst of claim 48, wherein said ligand is selected from the group consisting of compounds represented by the following formulas:



wherein each X and X' is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z and Z₁ is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide; or wherein Z and Z₁ together form the bridging group A-B-A₁;

wherein each Z', Z'', Z'₁' and Z'₁'' is independently selected from the group consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide; or wherein Z' and Z together form the bridging group A'-B-A; Z' and Z together form a fused cycloaliphatic or aromatic group; Z₁ and Z'₁' together form the bridging group A₁-B₁-A₁'; and/or Z₁ and Z'₁' together form a fused cycloaliphatic or aromatic group;

wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

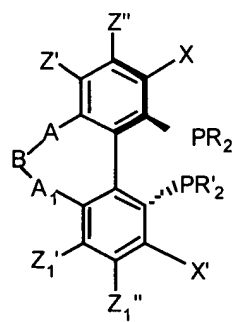
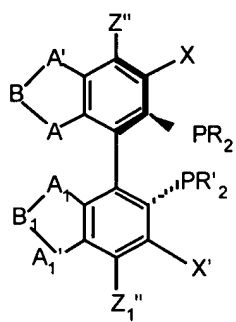
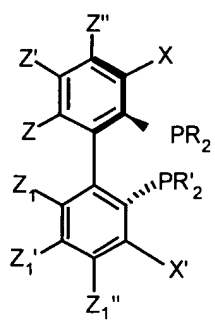
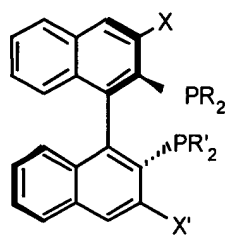
wherein each B and B₁ is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO, SO₂, and a bond;

wherein each YR', YR'', Y'R' and Y''R'' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide and aryloxide; or wherein two YR', YR'', Y'R' or Y''R'' groups together form an alkylene, arylene, alkylenediamino, arylenediamino, alkylenedioxyl or arylenedioxyl;

wherein each R, R' and R'' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, aralkyl and alkaryl of 1 to 22 carbon atoms; or wherein two R groups, two R' groups or two R'' group together form an alkylene or arelenearylene group; and

wherein each Y, Y' and Y'' is independently selected from the group consisting of: CH₂, and a bond between carbon and phosphorus; with the proviso that when the Y group at the 2' position is a bond between carbon and phosphorus, X' is hydrogen.

60. (currently amended) The catalyst of claim 48, wherein said ligand is selected from the group consisting of compounds represented by the following formulas:



wherein each X is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each X' is independently selected from the group consisting of: hydrogen, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z and Z₁ is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z', Z'', Z₁' and Z₁'' is independently selected from the group consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

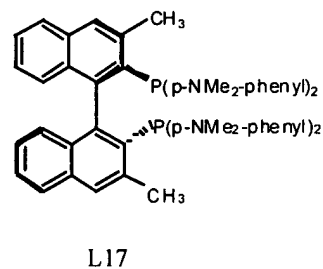
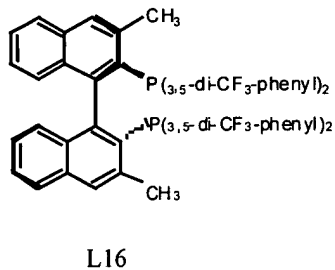
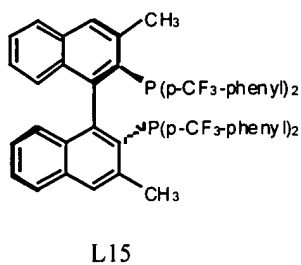
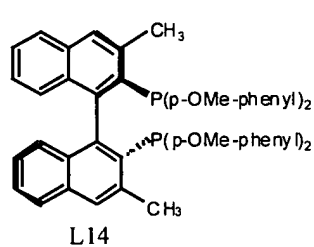
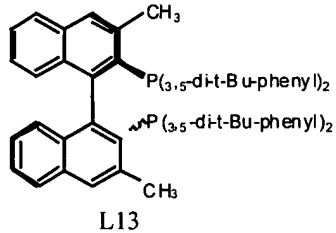
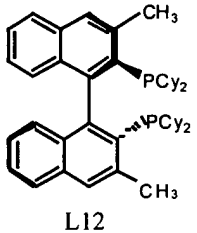
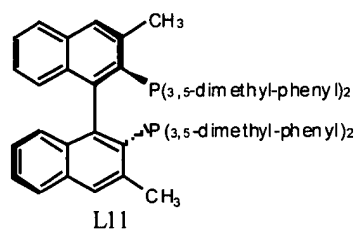
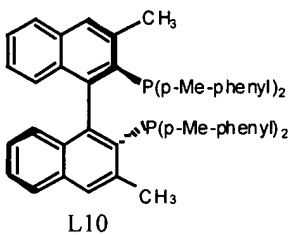
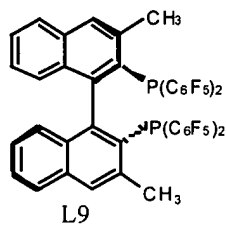
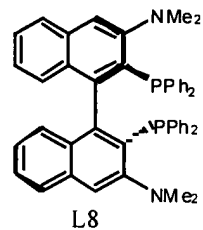
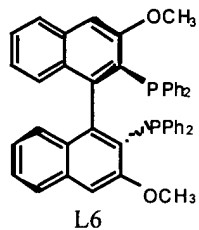
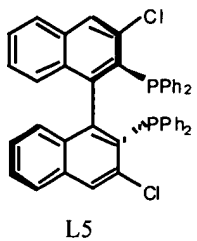
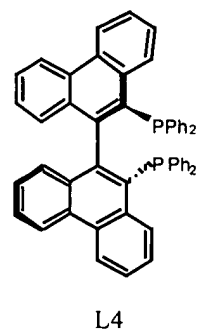
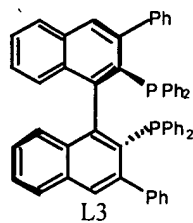
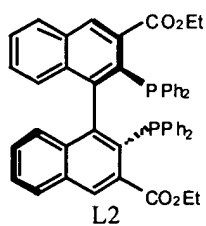
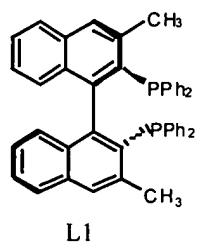
wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

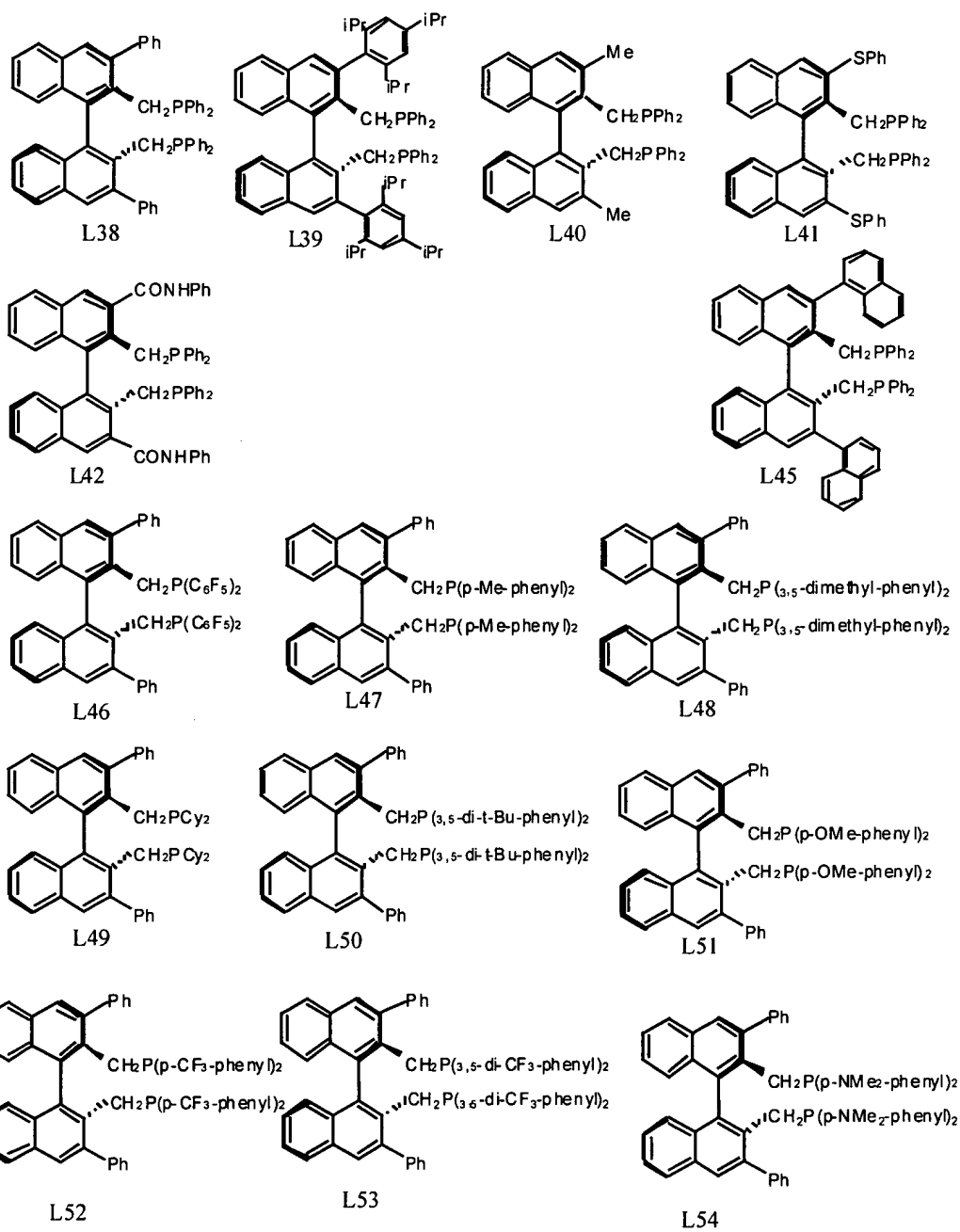
wherein each B and B₁ is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO, SO₂, and a bond;

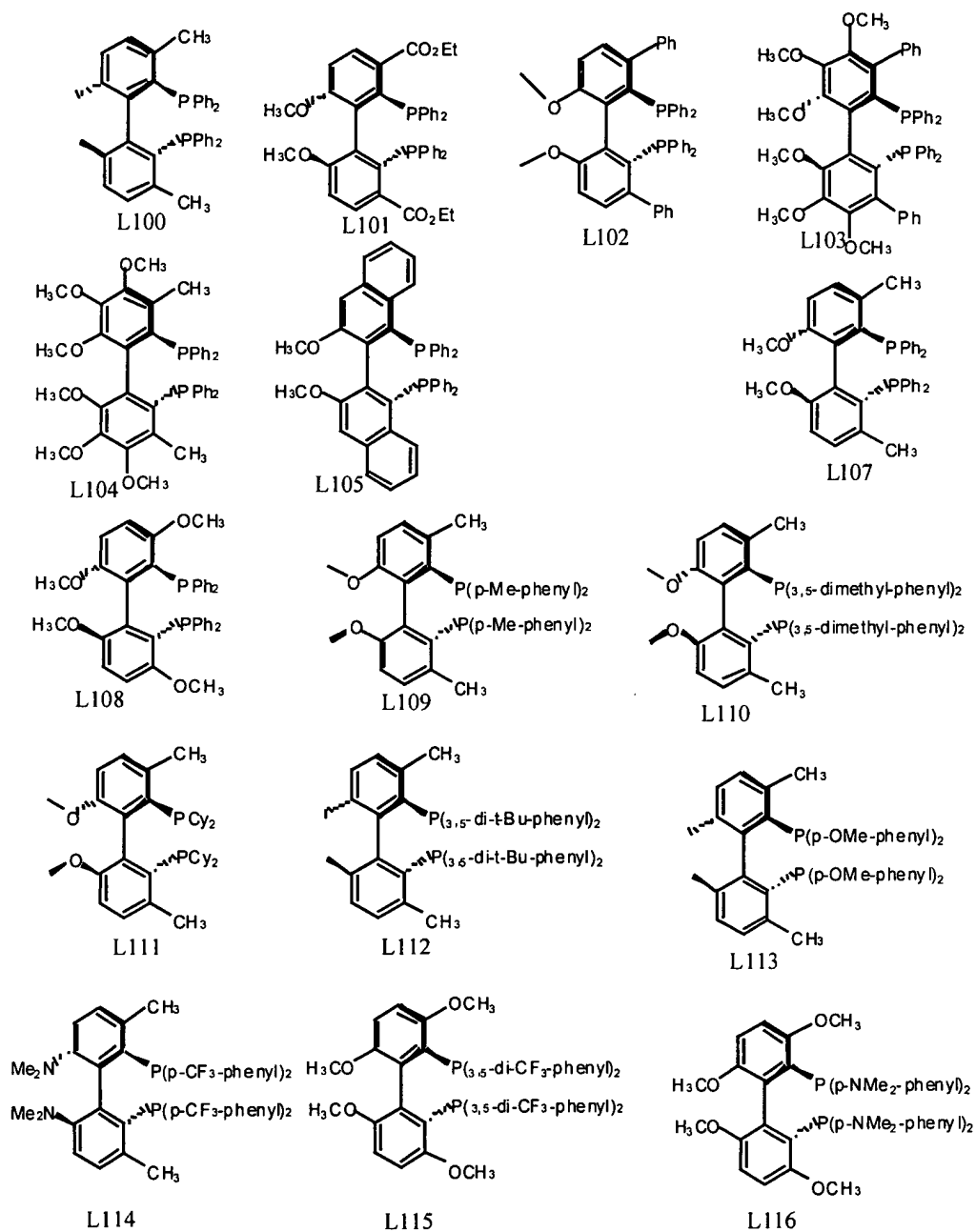
wherein each R and R' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, aralkyl and alkaryl of 1 to 22 carbon atoms, alkoxide and aryloxide; or

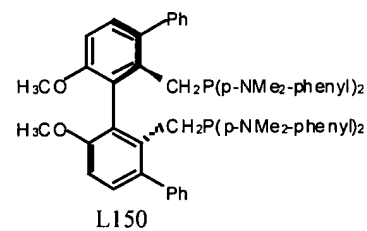
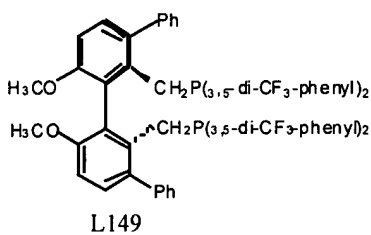
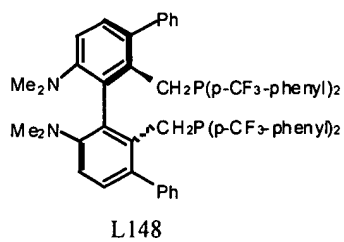
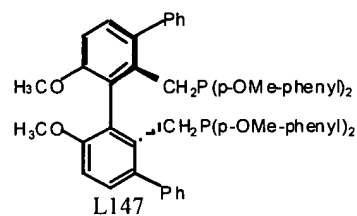
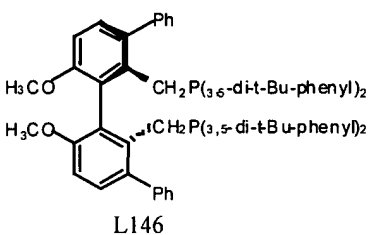
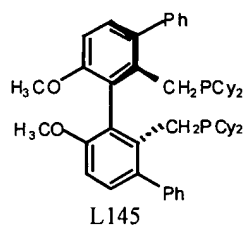
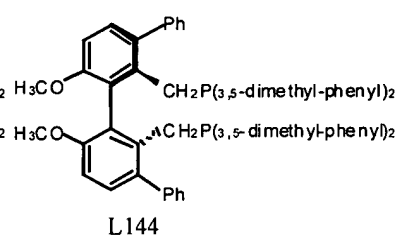
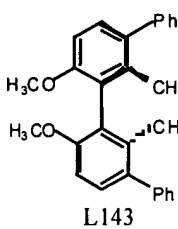
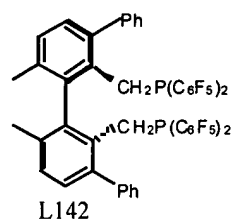
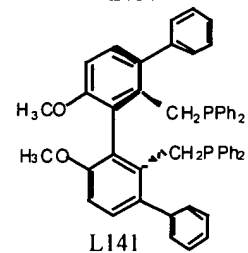
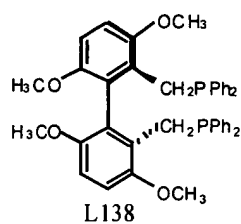
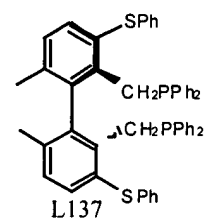
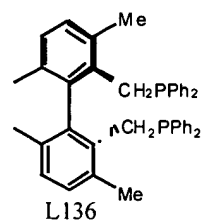
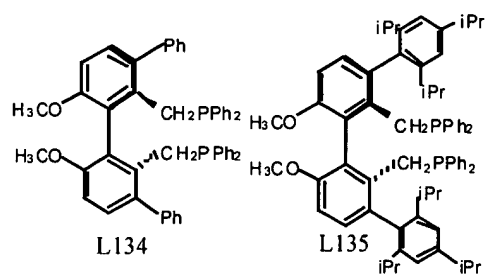
wherein two R groups or two R' groups together form an alkylene, or arelenearylene groups.

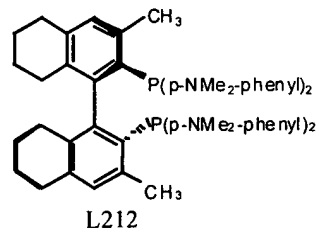
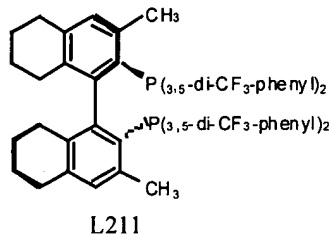
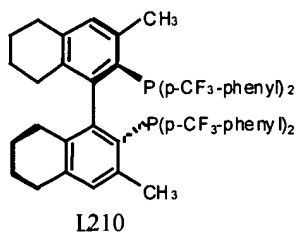
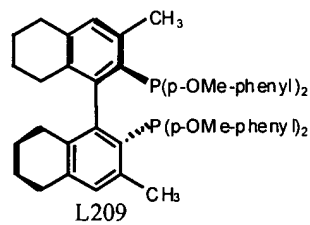
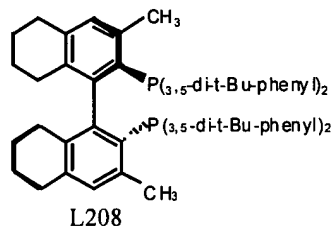
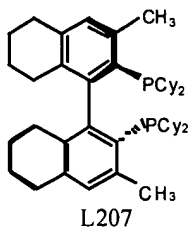
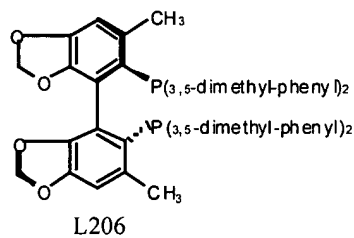
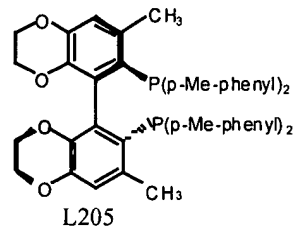
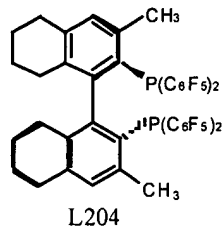
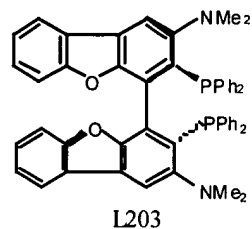
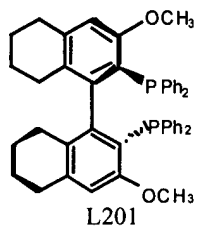
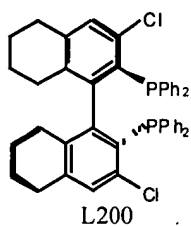
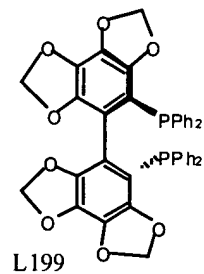
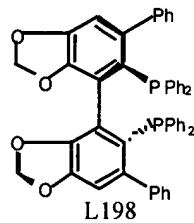
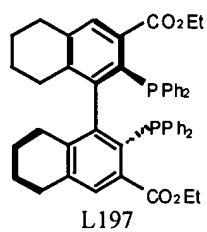
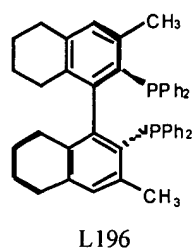
61. (previously presented) ~~The catalyst of claim 48, wherein said ligand is selected from the group consisting of compounds represented by the formulas:~~ A catalyst prepared by a process comprising contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:

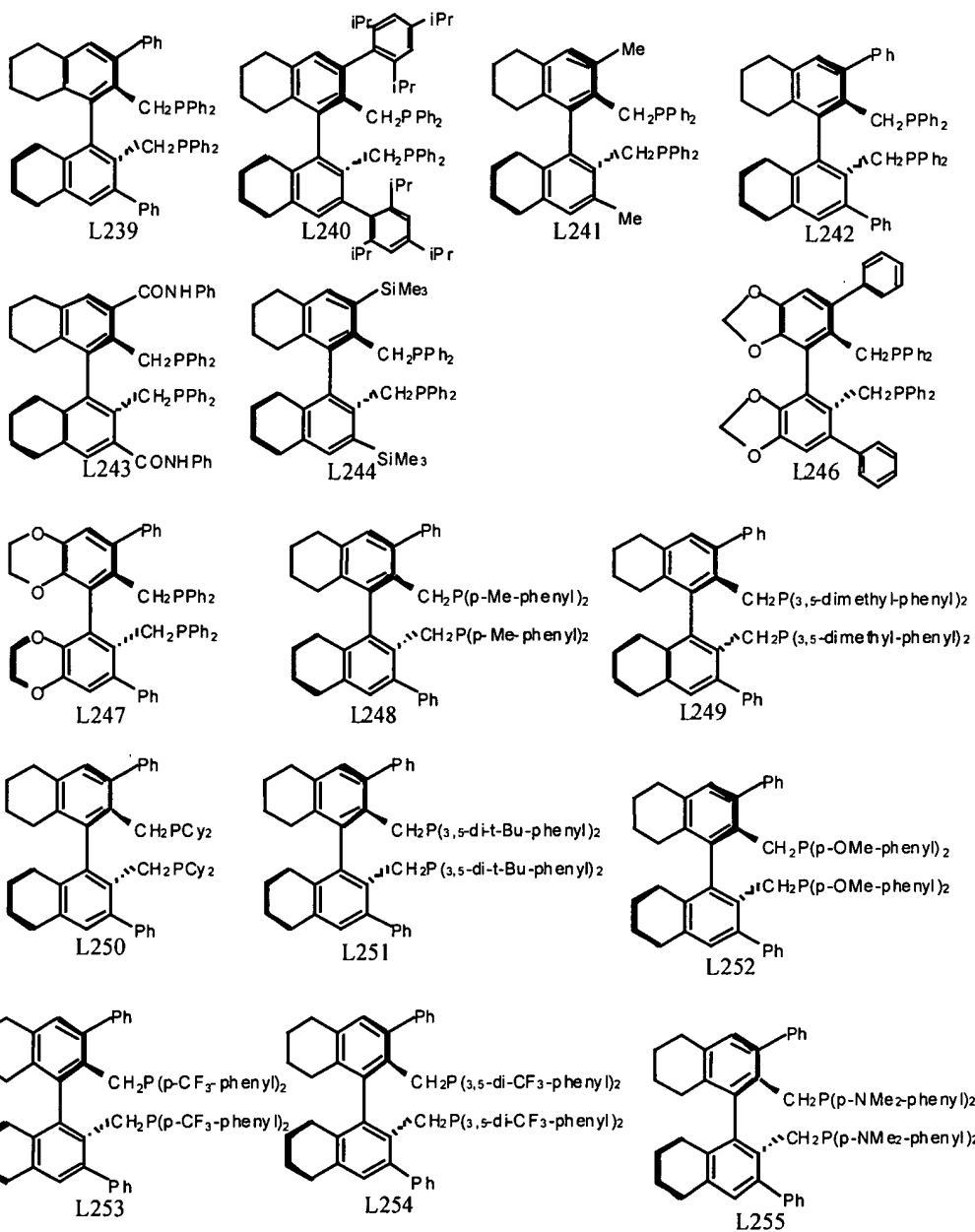


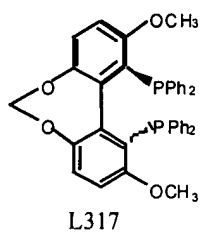
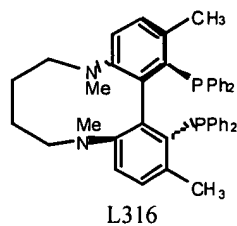
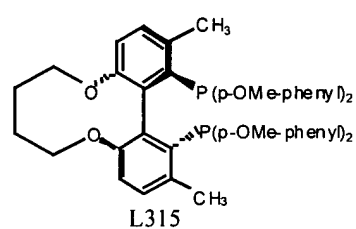
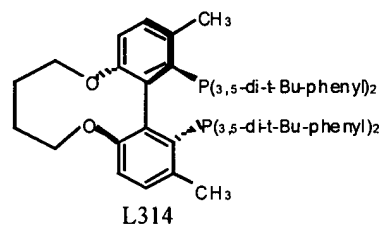
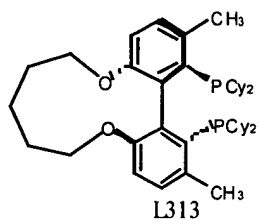
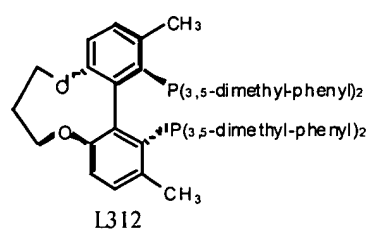
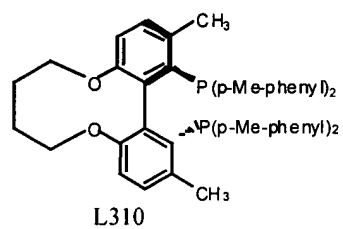
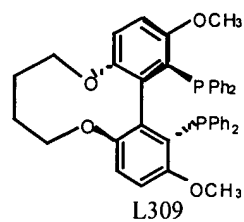
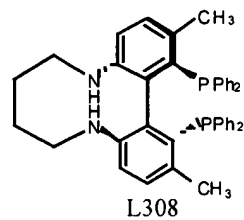
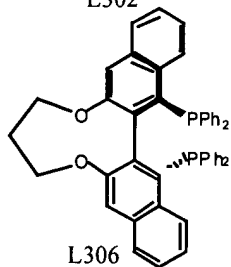
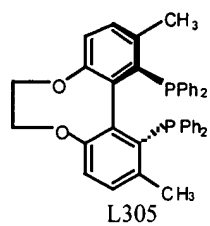
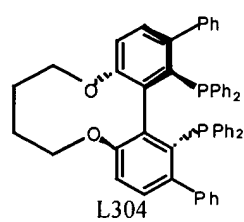
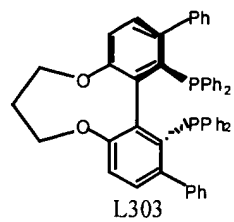
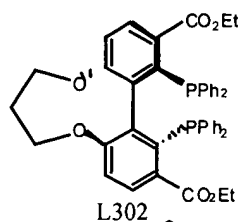
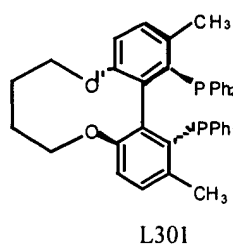


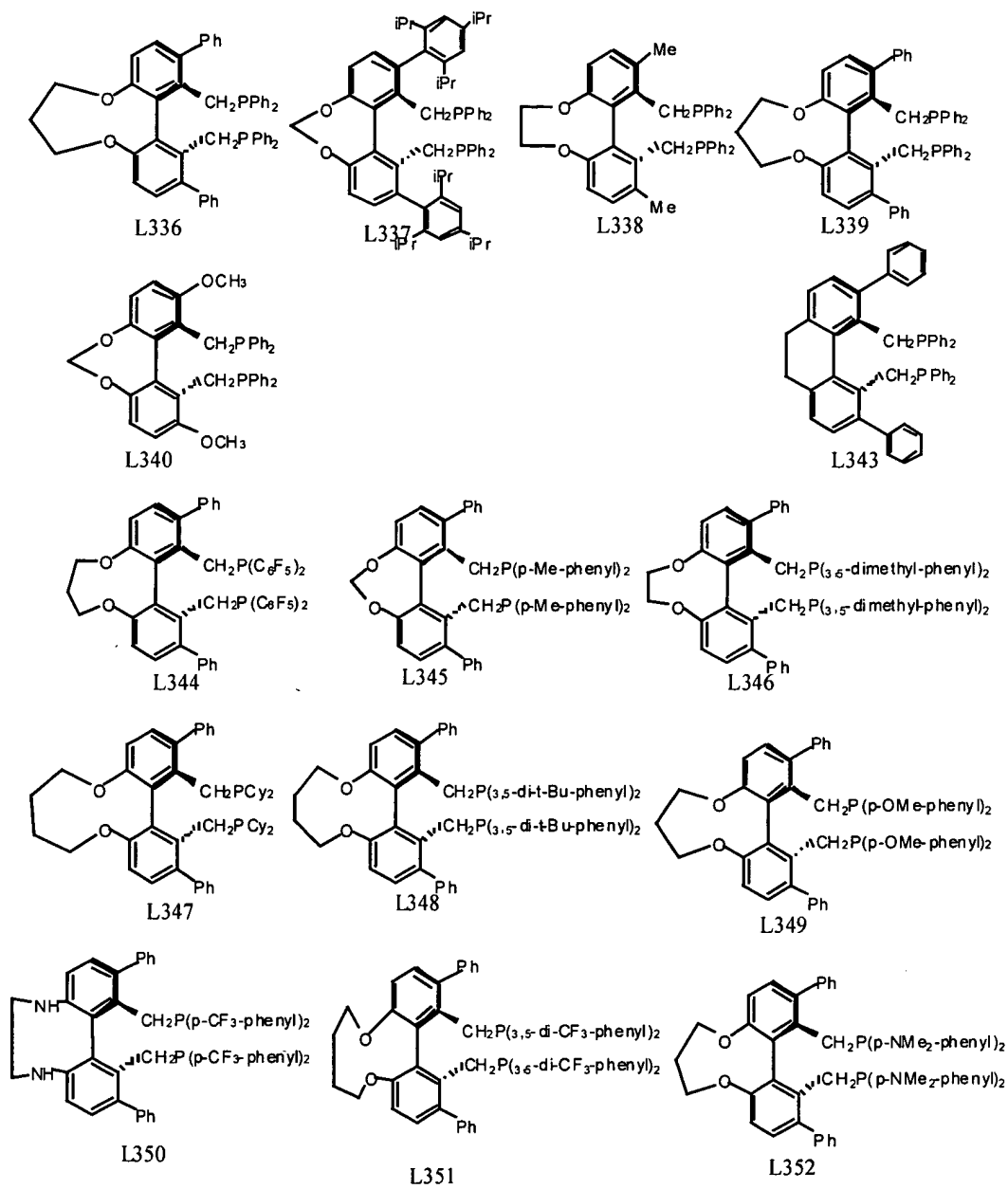






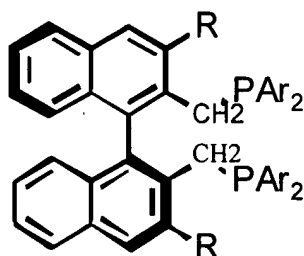






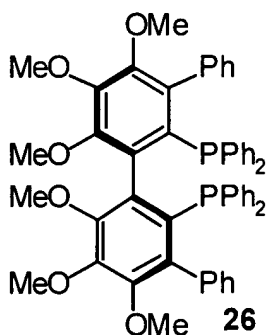
wherein Cy is a cyclohexyl group.

62. (previously presented) The catalyst of claim 48, wherein said ligand is represented by the formula:

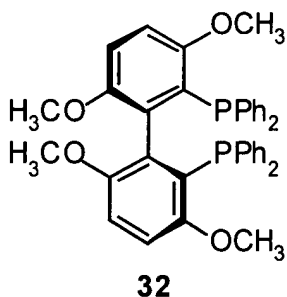


wherein each R is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, and substituted aryl; and wherein each Ar is independently selected from the group consisting of: phenyl, substituted phenyl, aryl and substituted aryl.

63. (previously presented) ~~The catalyst of claim 48, wherein said ligand is represented by the formula:~~ A catalyst prepared by a process comprising contacting a transition metal salt, or a complex thereof, and a ligand represented by the formula or its enantiomer:



64. (previously presented) ~~The catalyst of claim 48, wherein said ligand is represented by the formula:~~ A catalyst prepared by a process comprising contacting a transition metal salt, or a complex thereof, and a ligand represented by the formula or its enantiomer:



65. (previously presented) The catalyst of claim 48, wherein said transition metal is selected from the group consisting of:

Ag, Pt, Pd, Rh, Ru, Ir, Cu, Ni, Mo, Ti, V, Re and Mn.

66. (previously presented) The catalyst of claim 48, wherein said transition metal is selected from the group consisting of:

Pt, Pd, Rh and Ru.

67. (previously presented) The catalyst of claim 48, wherein said transition metal salt, or complex thereof, is selected from the group consisting of:

AgX; Ag(OTf); Ag(OTf)₂; AgOAc; PtCl₂; H₂PtCl₄; Pd₂(DBA)₃; Pd(OAc)₂;
 PdCl₂(RCN)₂; (Pd(allyl)Cl)₂; Pd(PR₃)₄; (Rh(NBD)₂)X; (Rh(NBD)Cl)₂; (Rh(COD)Cl)₂;
 (Rh(COD)₂)X; Rh(acac)(CO)₂; Rh(ethylene)₂(acac); (Rh(ethylene)₂Cl)₂; RhCl(PPh₃)₃;
 Rh(CO)₂Cl₂; RuHX(L)₂(diphosphine), RuX₂(L)₂(diphosphine),
 Ru(arene)X₂(diphosphine), Ru(aryl group)X₂; Ru(RCOO)₂(diphosphine);

$\text{Ru}(\text{methallyl})_2(\text{diphosphine})$; $\text{Ru}(\text{aryl group})\text{X}_2(\text{PPh}_3)_3$; $\text{Ru}(\text{COD})(\text{COT})$;
 $\text{Ru}(\text{COD})(\text{COT})\text{X}$; $\text{RuX}_2(\text{cymene})$; $\text{Ru}(\text{COD})_n$; $\text{Ru}(\text{aryl group})\text{X}_2(\text{diphosphine})$;
 $\text{RuCl}_2(\text{COD})$; $(\text{Ru}(\text{COD})_2)\text{X}$; $\text{RuX}_2(\text{diphosphine})$; $\text{RuCl}_2(=\text{CHR})(\text{PR}'_3)_2$; $\text{Ru}(\text{ArH})\text{Cl}_2$;
 $\text{Ru}(\text{COD})(\text{methallyl})_2$; $(\text{Ir}(\text{NBD})_2\text{Cl})_2$; $(\text{Ir}(\text{NBD})_2)\text{X}$; $(\text{Ir}(\text{COD})_2\text{Cl})_2$; $(\text{Ir}(\text{COD})_2)\text{X}$; CuX
 $(\text{NCCH}_3)_4$; $\text{Cu}(\text{OTf})$; $\text{Cu}(\text{OTf})_2$; $\text{Cu}(\text{Ar})\text{X}$; CuX ; $\text{Ni}(\text{acac})_2$; NiX_2 ; $(\text{Ni}(\text{allyl})\text{X})_2$; $\text{Ni}(\text{COD})_2$;
 $\text{MoO}_2(\text{acac})_2$; $\text{Ti}(\text{OiPr})_4$; $\text{VO}(\text{acac})_2$; MeReO_3 ; MnX_2 and $\text{Mn}(\text{acac})_2$; wherein each R
 and R' is independently selected from the group consisting of: alkyl or aryl; Ar is an aryl
 group; and X is a counteranion.

68. (currently amended) The catalyst of claim 67, wherein L is a solvent molecule
 and wherein said counteranion X is selected from the group consisting of: halogen,
 BF_4 , $\text{B}(\text{Ar})_4$, wherein the Ar in the $\text{B}(\text{Ar})_4$ is fluorophenyl or 3,5-di-trifluoromethyl-1-
 phenyl, ClO_4 , SbF_6 , PF_6 , CF_3SO_3 , RCOO and a mixture thereof.

69. (previously presented) The catalyst of claim 48, prepared in situ or as an
 isolated compound.

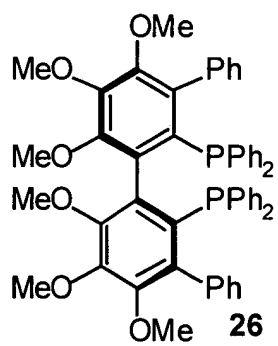
70. (currently amended) ~~The catalyst of claim 48, A catalyst prepared by a~~
process comprising contacting a transition metal salt, or a complex thereof, and a
ligand;

wherein said transition metal salt, or a complex thereof is selected from the
 group consisting of:

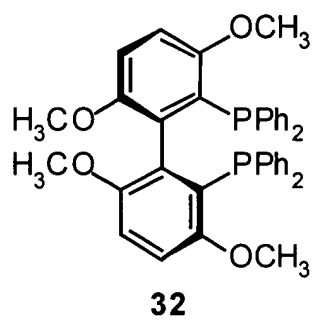
$[\text{Rh}(\text{COD})\text{Cl}]_2$, $[\text{Rh}(\text{COD})_2]\text{X}$, $[\text{Ir}(\text{COD})\text{Cl}]_2$, $[\text{Ir}(\text{COD})_2]\text{X}$, $\text{Rh}(\text{acac})(\text{CO})_2$,
 $\text{Ni}(\text{allyl})\text{X}$, $\text{Pd}_2(\text{dba})(\text{DBA})_3$, $[\text{Pd}(\text{allyl})\text{Cl}]_2$, $\text{Ru}(\text{RCOO})_2(\text{diphosphine})$,
 $\text{RuX}_2(\text{diphosphine})$, $\text{Ru}(\text{methylallyl})_2(\text{diphosphine})$ and $\text{Ru}(\text{aryl})\text{X}_2(\text{diphosphine})$,
 wherein X is selected from the group consisting of: BF_4 , ClO_4 , SbF_6 , CF_3SO_3 , Cl and
 Br; and

wherein said ligand is selected from the group consisting of compounds
 represented by the formula:

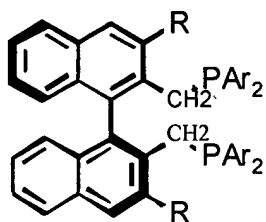
(a)



(b)



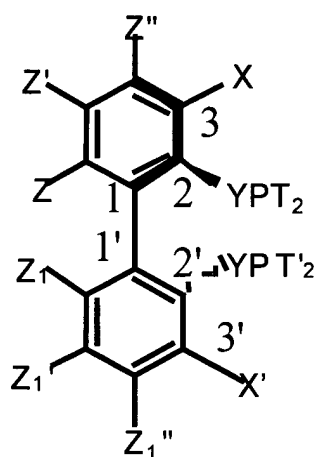
(c)



and a combination thereof.

71. (currently amended) A process for preparation of an asymmetric compound comprising:

contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:



wherein each X and X' is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z and Z₁ is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR and halide; or wherein Z and Z₁ together form the bridging group A-B-A₁;

wherein each Z', Z'', Z₁' and Z₁'' is independently selected from the group consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide; or wherein Z' and Z together form the bridging group A'-B-A; Z' and Z together form a fused cycloaliphatic or aromatic group; Z₁ and Z₁' together form the bridging group A₁-B₁-A₁'; and/or Z₁ and Z₁' together form a fused cycloaliphatic or aromatic group;

wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

wherein each B and B₁ is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO, SO₂, and a bond;

wherein each T is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide, aryloxide, R, R', and R"; or wherein two T groups together form an alkylene or arylene;

wherein each T' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide, aryloxide, R, R', and R"; or wherein two T' groups together form an alkylene or arylene;

wherein each R, R' and R" is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, aralkyl and alkaryl of 1 to 22 carbon atoms; or wherein two R groups, two R' groups or two R" group together form an alkylene, arelene, arylene or substituted arylene group; and

wherein each Y, Y' and Y" is independently selected from the group consisting of: CH₂ and a bond between carbon and phosphorus; with the proviso that when the Y group at the 2' position is a bond between carbon and phosphorus, X' is hydrogen;

wherein said asymmetric reaction is selected from the group consisting of: hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.

72. (canceled)

73. (currently amended) The process of claim ~~72~~71, wherein said asymmetric reaction is hydrogenation and said substrate is selected from the group consisting of: imine, ketone, ethylenically unsaturated compound, enamine, enamide and vinyl ester.

74. (currently amended) The process of claim 7271, wherein said asymmetric reaction is a silver-catalyzed asymmetric [3 +2] cycloaddition of an azomethine ylide with a dipolarophile.

75. (currently amended) The process of claim 7271, wherein said asymmetric reaction is a palladium-catalyzed allylic alkylation and said substrate is an allylic ester.

76. (currently amended) The process of claim 7271, wherein said asymmetric palladium-catalyzed allylic alkylation reaction is a kinetic resolution reaction and said substrate is a racemic allylic ester.

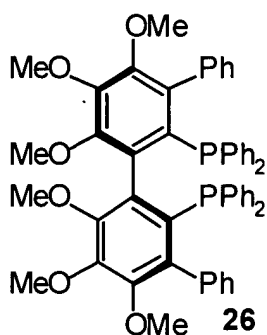
77. (currently amended) The process of claim 7271, wherein said asymmetric reaction is hydrogenation, said substrate is a beta-ketoester, said transition metal is Ru and said asymmetric compound is a beta-hydroxyester.

78. (currently amended) The process of claim 7271, wherein said asymmetric reaction is hydrogenation, said substrate is an enamide, said transition metal is Ru and said asymmetric compound is a beta amino acid.

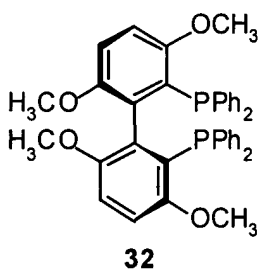
79. (currently amended) ~~The process of claim 72, wherein said ligand is selected from the group consisting of compounds represented by the formula:~~ A process for preparation of an asymmetric compound comprising:

contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:

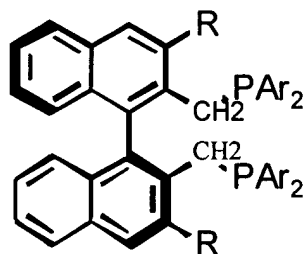
(a)



(b)



(c)



and a combination thereof;

wherein said asymmetric reaction is selected from the group consisting of:

hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.

80. (previously presented) The process of claim 79, wherein said asymmetric reaction is hydrogenation, said substrate is a beta-ketoester, said transition metal is Ru and said asymmetric compound is a beta-hydroxyester.

81. (previously presented) The process of claim 79, wherein said asymmetric reaction is hydrogenation, said substrate is an enamide, said transition metal is Ru and said asymmetric compound is a beta amino acid.

82. (previously presented) The process of claim 71, wherein said substituted alkyl has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, carboxylic acid, hydroxy, alkoxy, aryloxy, thiol, alkylthio and dialkylamino.

83. (previously presented) The process of claim 71, wherein said alkylene is selected from the group consisting of compounds represented by the formula: $-(CH_2)_n-$, where n is an integer in the range of from 1 to 8.

84. (previously presented) The process of claim 71, wherein each of said aryl groups optionally has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, sulfonate, phosphonate, hydroxy, alkoxy, aryloxy, thiol, alkylthiol, nitro, amino, vinyl, substituted vinyl, carboxylic acid, sulfonic acid and phosphine.

85. (previously presented) The process of claim 71, wherein each of said arylene groups optionally has one or more substituents, each independently selected from the group consisting of: halogen, ester, ketone, sulfonate, phosphonate, hydroxy, alkoxy, aryloxy, thiol, alkylthiol, nitro, amino, vinyl, substituted vinyl, carboxylic acid, sulfonic acid and phosphine.

86. (previously presented) The process of claim 71, wherein each of said arylene groups is independently selected from the group consisting of: 1,2-divalent phenyl, 2,2'-divalent-1,1'-biphenyl, 2,2'-divalent-1,1'-binaphthyl and ferrocene.

87. (previously presented) The process of claim 71, wherein said ligand is a racemic mixture of enantiomers.

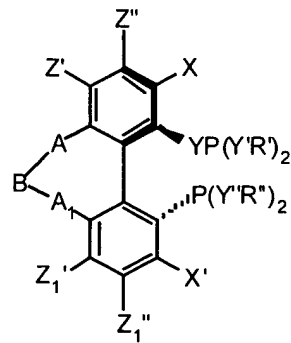
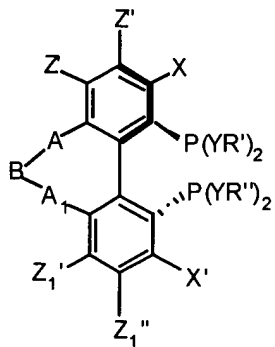
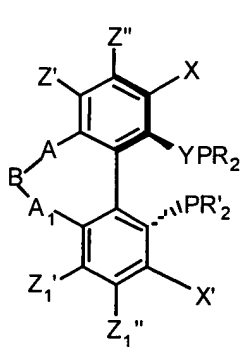
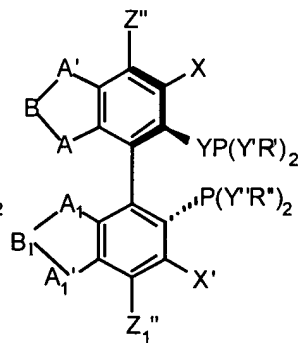
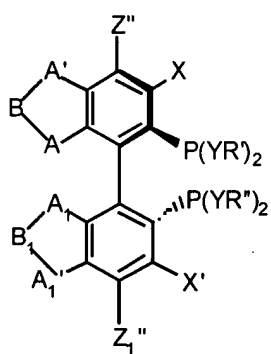
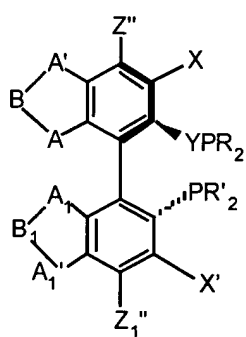
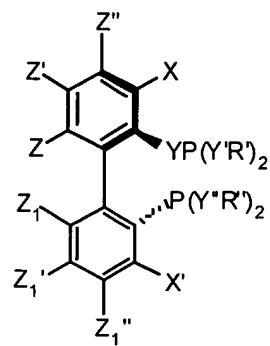
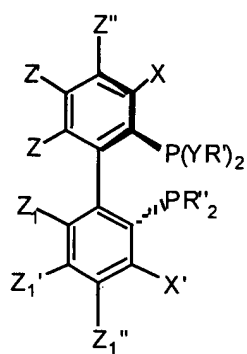
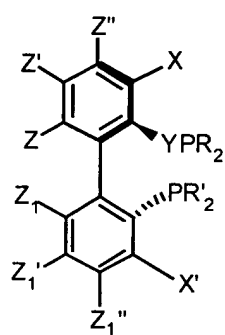
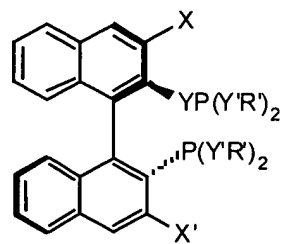
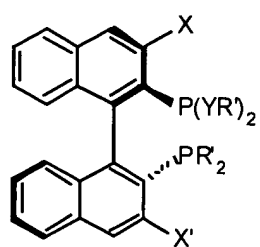
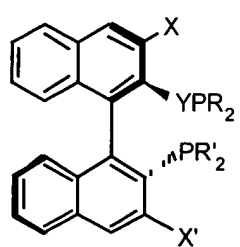
88. (previously presented) The process of claim 71, wherein said ligand is a non-racemic mixture of enantiomers.

89. (previously presented) The process of claim 71, wherein said ligand is one of the enantiomers.

90. (previously presented) The process of claim 71, wherein said ligand has an optical purity of at least 85% ee.

91. (previously presented) The process of claim 71, wherein said ligand has an optical purity of at least 95% ee.

92. (previously presented) The process of claim 71, wherein said ligand is selected from the group consisting of compounds represented by the following formulas:



wherein each X and X' is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z and Z₁ is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide; or wherein Z and Z₁ together form the bridging group A-B-A₁;

wherein each Z', Z'', Z₁' and Z₁'' is independently selected from the group consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide; or wherein Z' and Z together form the bridging group A'-B-A; Z' and Z together form a fused cycloaliphatic or aromatic group; Z₁ and Z₁' together form the bridging group A₁-B₁-A₁'; and/or Z₁ and Z₁' together form a fused cycloaliphatic or aromatic group;

wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

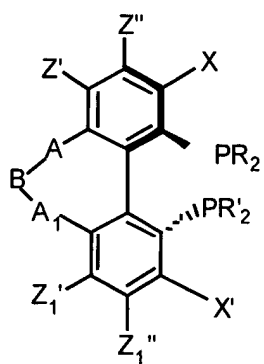
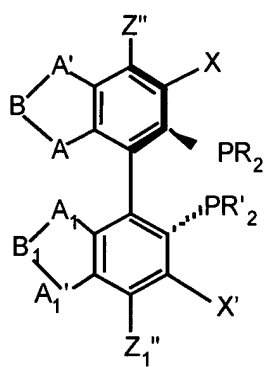
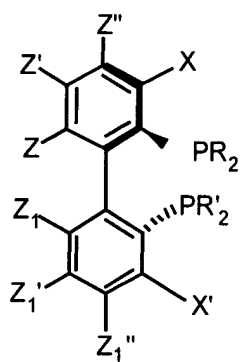
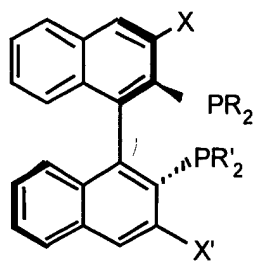
wherein each B and B₁ is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO, SO₂, and a bond;

wherein each YR', YR'', Y'R' and Y''R'' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, alkoxide and aryloxide; or wherein two YR', YR'', Y'R' or Y''R'' groups together form an alkylene, arylene, alkylenediamino, arylenediamino, alkylenedioxy or arylenedioxy;

wherein each R, R' and R'' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, aralkyl and alkaryl of 1 to 22 carbon atoms; or wherein two R groups, two R' groups or two R'' group together form an alkylene or arelenearylene group; and

wherein each Y, Y' and Y'' is independently selected from the group consisting of: CH₂, and a bond between carbon and phosphorus; with the proviso that when the Y group at the 2' position is a bond between carbon and phosphorus, X' is hydrogen.

93. (currently amended) The process of claim 71, wherein said ligand is selected from the group consisting of compounds represented by the following formulas:



wherein each X is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

~~wherein each X' is independently selected from the group consisting of: hydrogen, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;~~

wherein each Z and Z₁ is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each Z', Z'', Z₁' and Z₁'' is independently selected from the group consisting of: H, alkyl, aryl, substituted alkyl, substituted aryl, OR, SR, NR₂, COOR, and halide;

wherein each A, A', A₁ and A₁' is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO and a bond;

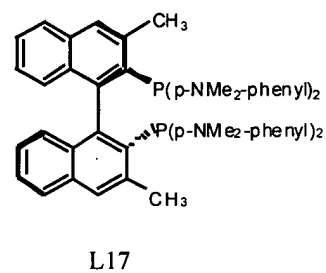
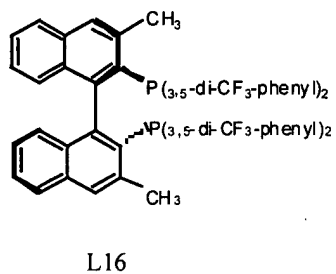
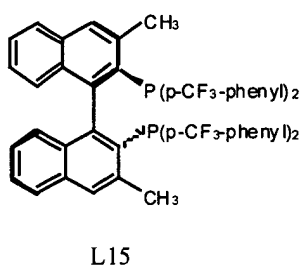
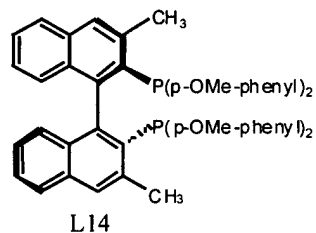
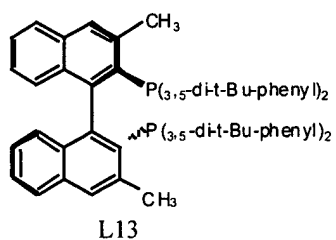
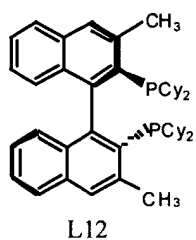
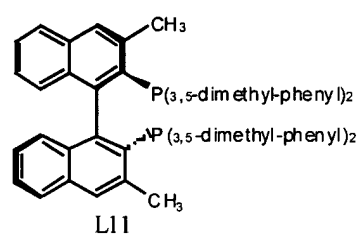
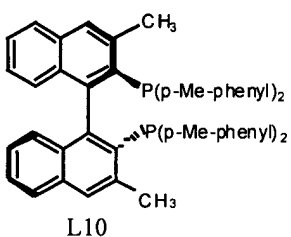
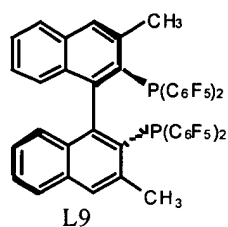
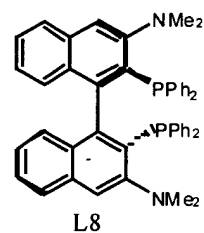
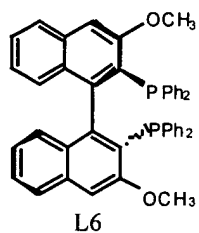
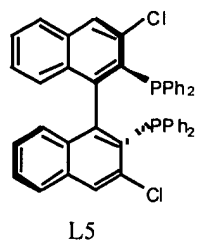
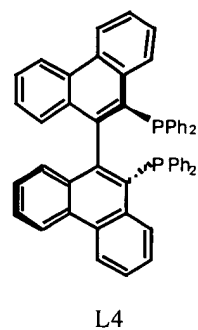
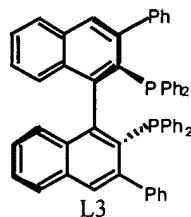
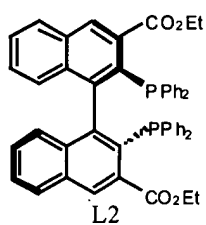
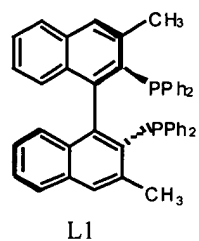
wherein each B and B₁ is independently selected from the group consisting of: O, CH₂, NH, NR, S, CO, SO₂, and a bond;

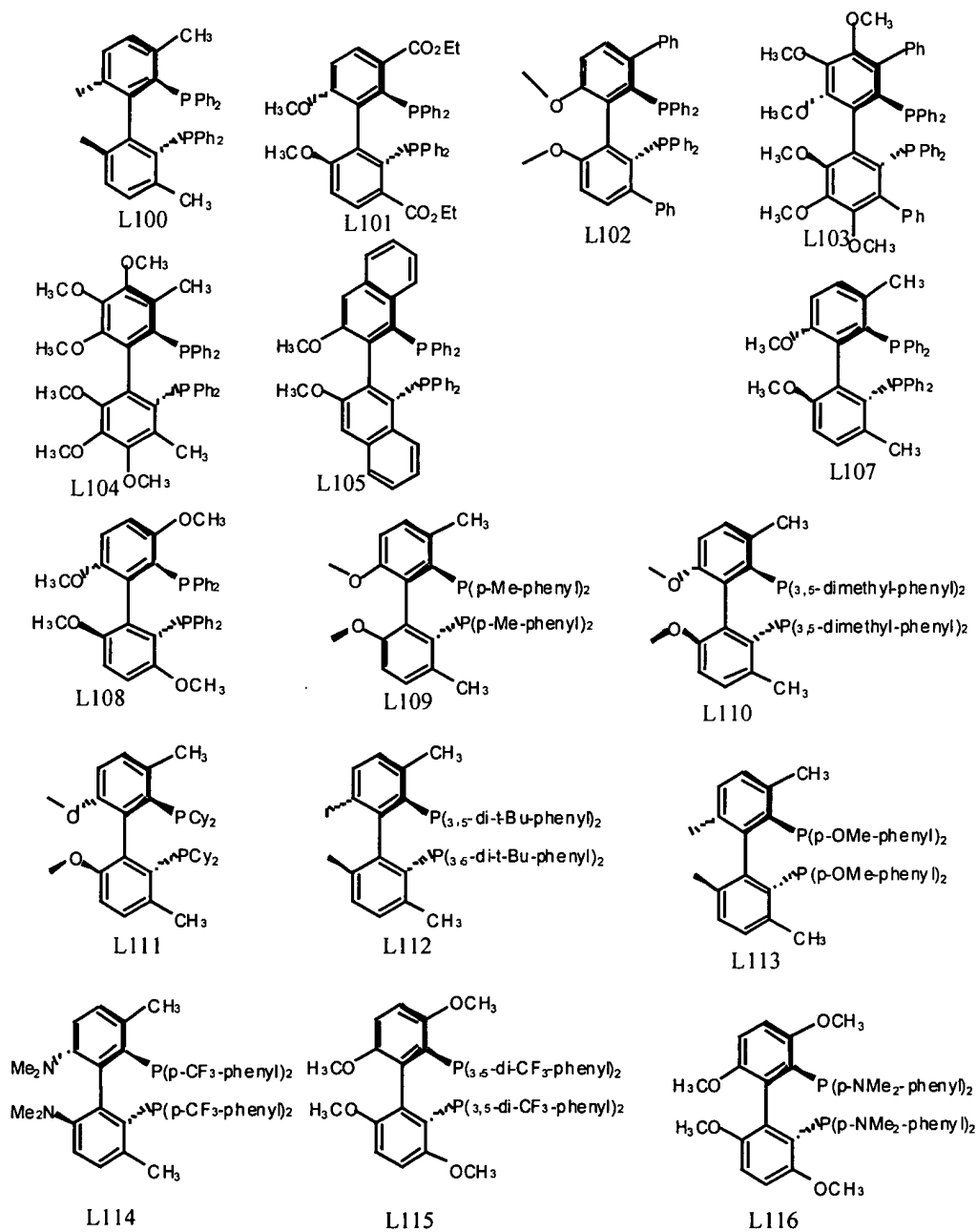
wherein each R and R' is independently selected from the group consisting of: alkyl, substituted alkyl, aryl, substituted aryl, aralkyl and alkaryl of 1 to 22 carbon atoms, alkoxide and aryloxide; or

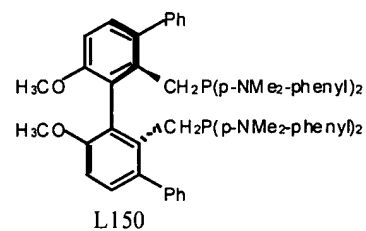
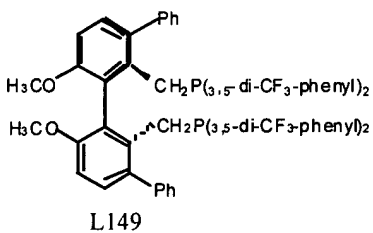
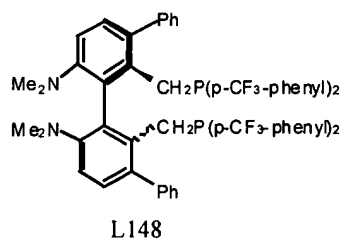
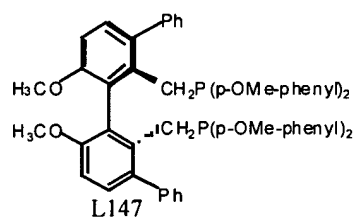
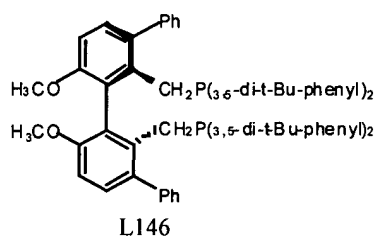
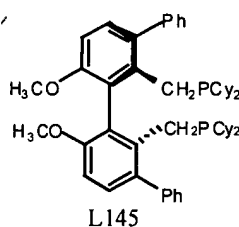
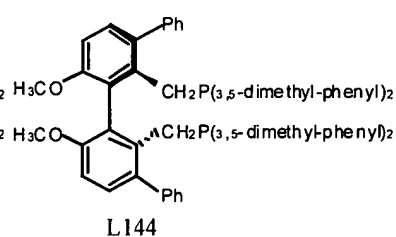
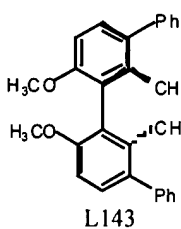
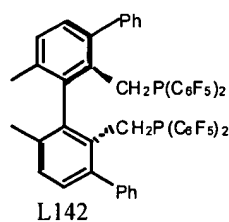
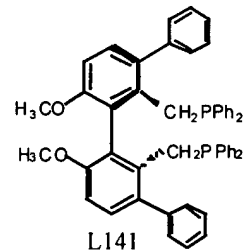
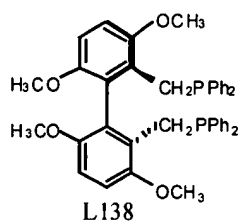
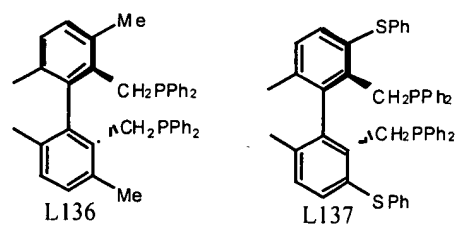
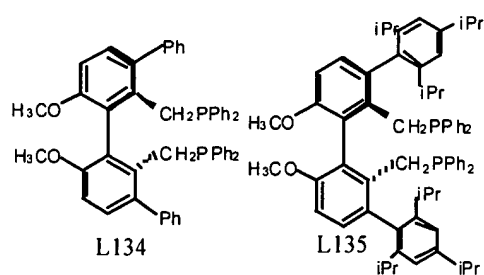
wherein two R groups or two R' groups together form an alkylene, or ~~arelene~~arylene groups.

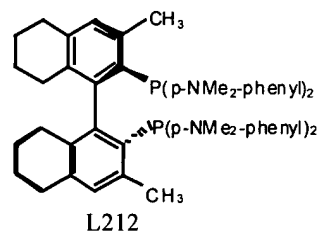
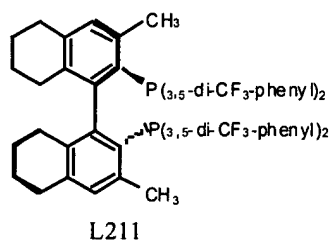
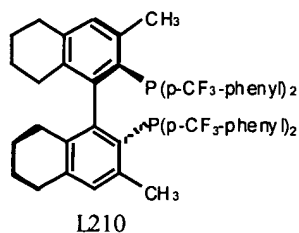
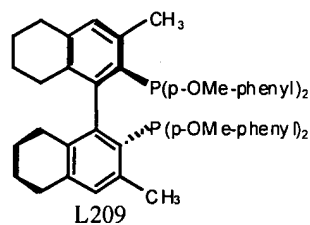
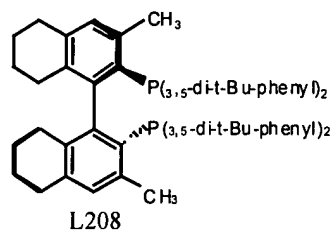
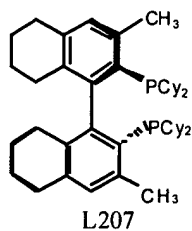
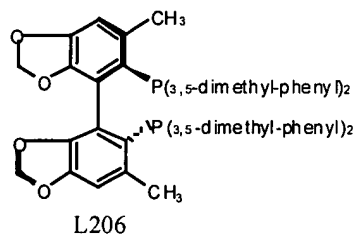
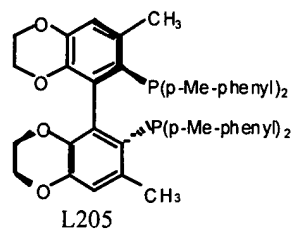
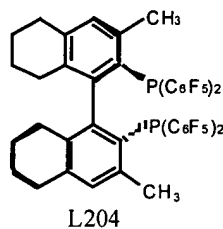
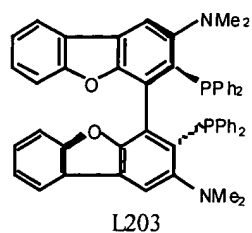
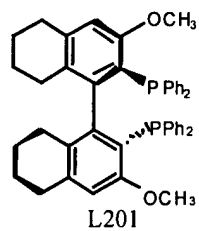
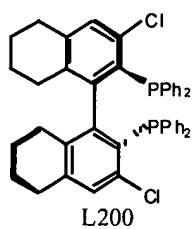
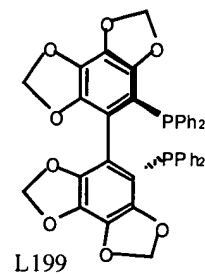
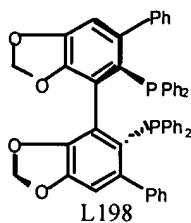
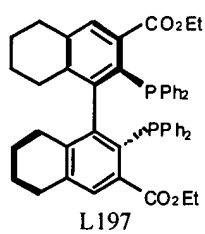
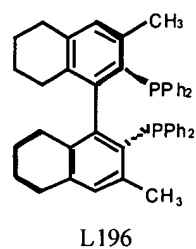
94. (currently amended) ~~The process of claim 71, wherein said ligand is selected from the group consisting of compounds represented by the formulas: A~~
process for preparation of an asymmetric compound comprising:

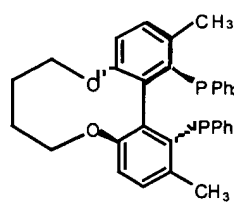
contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:



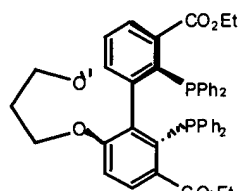




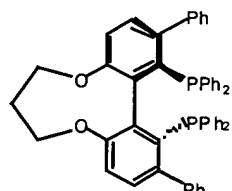




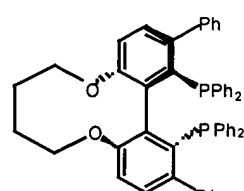
L301



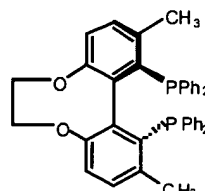
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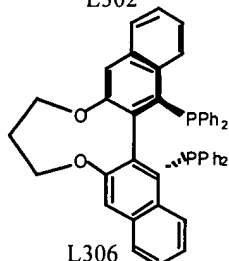
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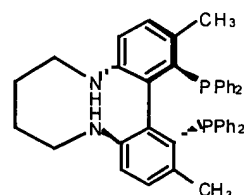
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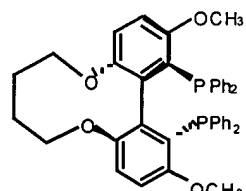
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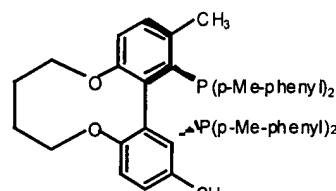
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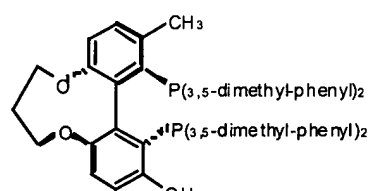
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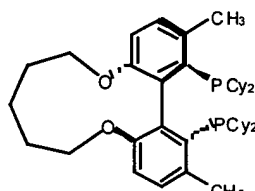
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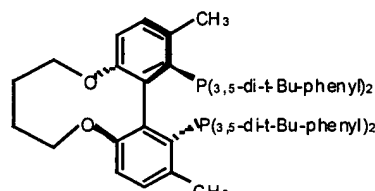
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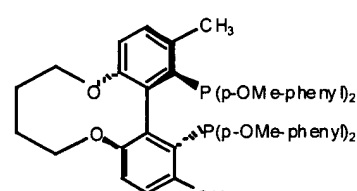
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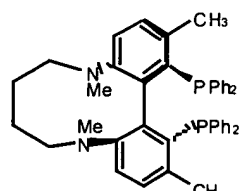
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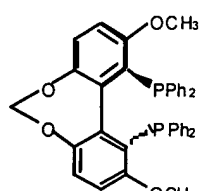
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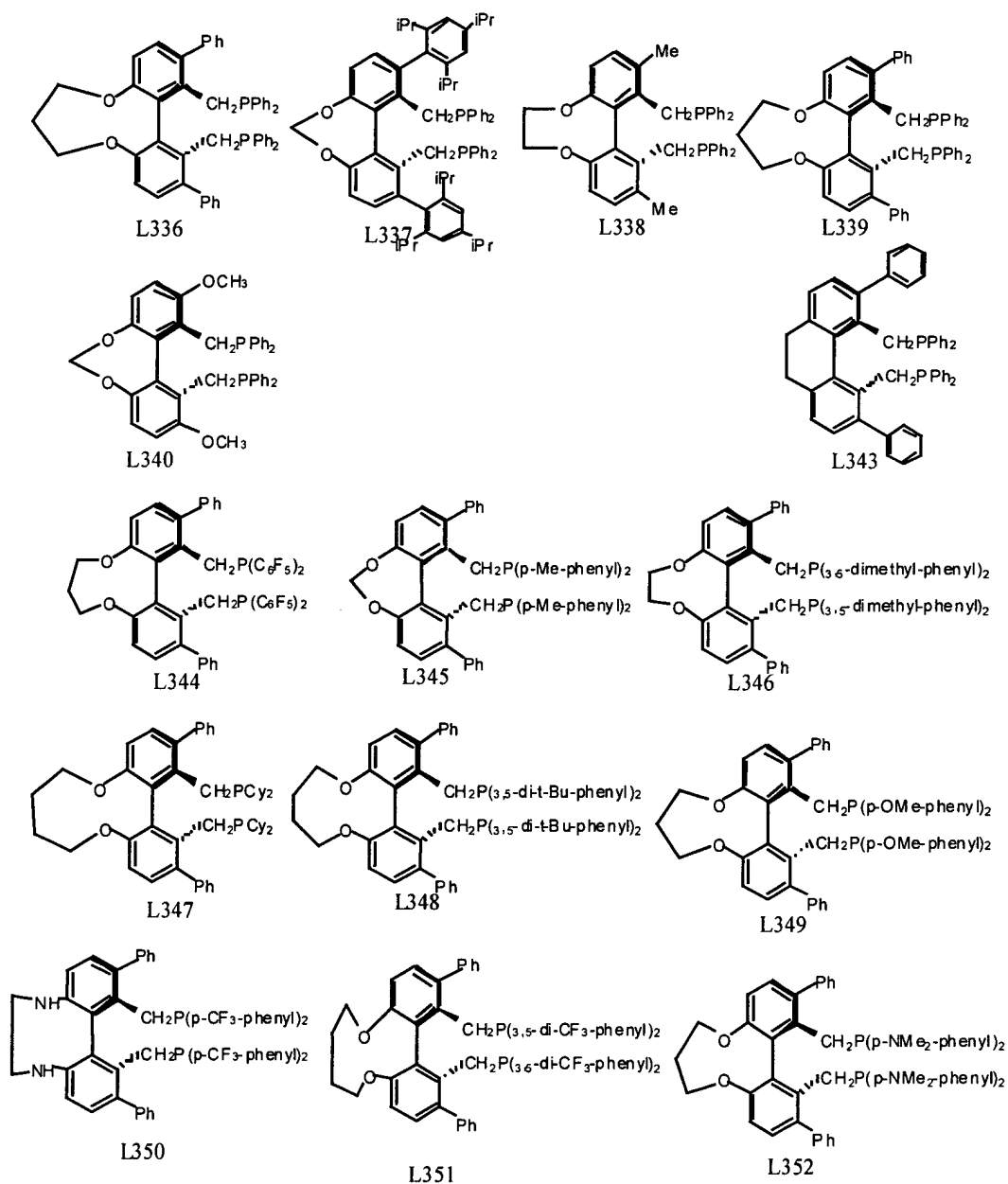
L315



L316



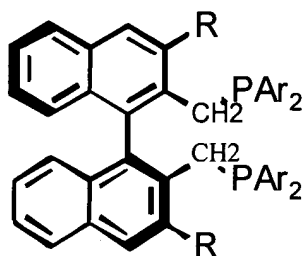
L317



wherein Cy is a cyclohexyl group;

wherein said asymmetric reaction is selected from the group consisting of: hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.

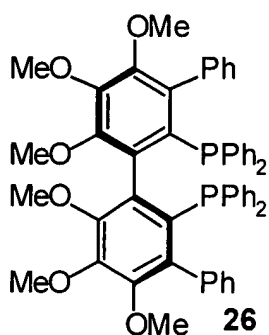
95. (previously presented) The process of claim 71, wherein said ligand is represented by the formula:



wherein each R is independently selected from the group consisting of: alkyl, aryl, substituted alkyl, and substituted aryl; and wherein each Ar is independently selected from the group consisting of: phenyl, substituted phenyl, aryl and substituted aryl.

96. (currently amended) ~~The process of claim 71, wherein said ligand is represented by the formula:~~ A process for preparation of an asymmetric compound comprising:

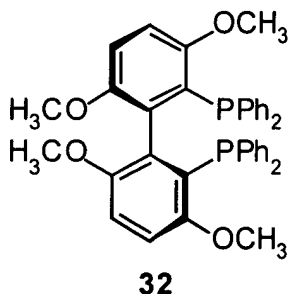
contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:



wherein said asymmetric reaction is selected from the group consisting of: hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.

97. (currently amended) ~~The process of claim 71, wherein said ligand is represented by the formula:~~ A process for preparation of an asymmetric compound comprising:

contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand selected from the group consisting of compounds represented by the formula or its enantiomer:



wherein said asymmetric reaction is selected from the group consisting of: hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.

98. (previously presented) The process of claim 71, wherein said transition metal is selected from the group consisting of:

Ag, Pt, Pd, Rh, Ru, Ir, Cu, Ni, Mo, Ti, V, Re and Mn.

99. (previously presented) The process of claim 71, wherein said transition metal is selected from the group consisting of:

Pt, Pd, Rh and Ru.

100. (previously presented) The process of claim 71, wherein said transition metal salt, or complex thereof, is selected from the group consisting of:

AgX; Ag(OTf); Ag(OTf)₂; AgOAc; PtCl₂; H₂PtCl₄; Pd₂(DBA)₃; Pd(OAc)₂; PdCl₂(RCN)₂; (Pd(allyl)Cl)₂; Pd(PR₃)₄; (Rh(NBD)₂)X; (Rh(NBD)Cl)₂; (Rh(COD)Cl)₂; (Rh(COD)₂)X; Rh(acac)(CO)₂; Rh(ethylene)₂(acac); (Rh(ethylene)₂Cl)₂; RhCl(PPh₃)₃; Rh(CO)₂Cl₂; RuHX(L)₂(diphosphine), RuX₂(L)₂(diphosphine), Ru(arene)X₂(diphosphine), Ru(aryl group)X₂; Ru(RCOO)₂(diphosphine); Ru(methallyl)₂(diphosphine); Ru(aryl group)X₂(PPh₃)₃; Ru(COD)(COT); Ru(COD)(COT)X; RuX₂(cymene); Ru(COD)_n; Ru(aryl group)X₂(diphosphine); RuCl₂(COD); (Ru(COD)₂)X; RuX₂(diphosphine); RuCl₂(=CHR)(PR'₃)₂; Ru(ArH)Cl₂; Ru(COD)(methallyl)₂; (Ir(NBD)₂Cl)₂; (Ir(NBD)₂)X; (Ir(COD)₂Cl)₂; (Ir(COD)₂)X; CuX(NCCH₃)₄; Cu(OTf); Cu(OTf)₂; Cu(Ar)X; CuX; Ni(acac)₂; NiX₂; (Ni(allyl)X)₂; Ni(COD)₂; MoO₂(acac)₂; Ti(OiPr)₄; VO(acac)₂; MeReO₃; MnX₂ and Mn(acac)₂; wherein each R and R' is independently selected from the group consisting of: alkyl or aryl; Ar is an aryl group; and X is a counteranion.

101. (currently amended) The process of claim 100, wherein L is a solvent molecule and wherein said counteranion X is selected from the group consisting of:

halogen, BF₄, B(Ar)₄, wherein the Ar in the B(Ar)₄ is fluorophenyl or 3,5-difluoromethyl-1-phenyl, ClO₄, SbF₆, PF₆, CF₃SO₃, RCOO and a mixture thereof .

102. (previously presented) The process of claim 71, prepared in situ or as an isolated compound.

103. (currently amended) ~~The process of claim 71,~~ A process for preparation of an asymmetric compound comprising:

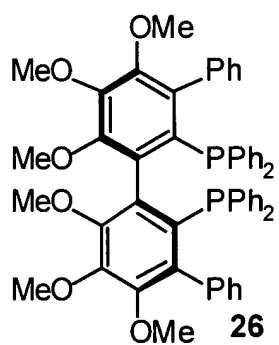
contacting a substrate capable of forming an asymmetric product by an asymmetric reaction and a catalyst prepared by a process comprising: contacting a transition metal salt, or a complex thereof, and a ligand;

wherein said transition metal salt, or a complex thereof is selected from the group consisting of:

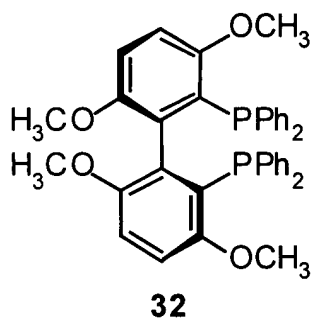
[Rh(COD)Cl]₂, [Rh(COD)₂]X, [Ir(COD)Cl]₂, [Ir(COD)₂]X, Rh(acac)(CO)₂, Ni(allyl)X, Pd₂(dba)₃, [Pd(allyl)Cl]₂, Ru(RCOO)₂(diphosphine), RuX₂(diphosphine), Ru(methylallyl)₂(diphosphine) and Ru(aryl)X₂(diphosphine), wherein X is selected from the group consisting of: BF₄, ClO₄, SbF₆, CF₃SO₃, Cl and Br; and

wherein said ligand is selected from the group consisting of compounds represented by the formula:

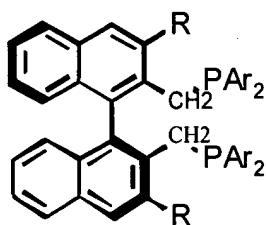
(a)



(b)



(c)



and a combination thereof;

wherein said asymmetric reaction is selected from the group consisting of:
hydrogenation, hydride transfer, allylic alkylation, hydrosilylation, hydroboration,

hydrovinylation, hydroformylation, olefin metathesis, hydrocarboxylation, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, isomerization, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m+n] cycloaddition wherein m = 3 to 6 and n = 2.